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PI(s) of MSM U01: Markus J. Buehler
Institution(s): Massachusetts Institute of Technology
MSM U01 Grant Number: HH4976
Title of Grant: Models to Predict Protein Biomaterial Performance

Abstract Authors

Isabelle Su, Christine Southworth, Ian Hattwick, Evan Ziporyn , Tomas Saraceno, Markus J. Buehler

Abstract Text

3D spider webs exhibit highly intricate and complex fiber architectures in addition to having excellent mechanical properties, they are also the most common type of webs found in nature. They have a hierarchical organization that spans orders of magnitude in length scale from the molecular silk protein, micrometer-sized fibers, and cm-scale spider web. Similarly, music has a hierarchical structure composed of sine wave building blocks that can be combined with others waveforms to create more complex timbre, which are then arranged within larger-scale musical compositions.

In this work, we use sonification, a visualization method through sound, and the analogy between music and spider webs, to translate the 3D *Cyrtophora citricola* spider web geometry into sound from which we can interpret the web's essential topological features. We use the game engine Unity3D and the audiovisual program Max7 to create an interactive spider web environment. The user travels through a virtual spider web and interacts with their surroundings by looking in different directions. Each silk fiber in their field of view are sonified using sine waves whose frequencies and amplitude are directly correlated to fiber length and distance from the user, respectively. Together, the sonified fibers create new and more complex timbre that reflects the architecture of 3D spider webs that have been digitally modeled with micron-scale details from full-scale laboratory experiments.

These concepts are implemented within The Spider's Canvas, a spider web-based instrument for live performances and art installations that explore a spider web's structure. It is a novel and creative way to immerse the composer and the audience into a holistic multimedia experience captured by the complexity of a 3D web.

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1	Define context clearly	Develop and document the subject, application, purpose, and intended use(s) of the model or simulation

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5	Use version control	Implement a system to trace the time history of M&S activities including delineation of contributors' efforts
6	Document adequately	Maintain up-to-date informative records of all M&S activities, including simulation code, model markup, scope and intended use of M&S activities, as well as users' and developers' guides
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